Claims

We claims:

1   1. A method for selecting multiple paths between a server and a client in an

2   overlay network having a plurality of nodes connected by links, the plurality

3   of nodes including the server and the client, each path including a set of

4   selected links, comprising:

5   measuring, in each node, quality of service metrics of each link

6   directly connecting the node to an immediate neighboring node;

7   transmitting the metrics to the server;

8   maintaining, in the server, the metrics, a link correlation matrix based

9   on the metrics, and a path correlation matrix based on the link correlation

10 matrix; and

11   selecting the multiple paths based only on the metrics, the link

12 correlation matrix, and the path correlation matrix.

1   2. The method of claim 1, further comprising:

2   streaming data from the server to the client via the multiple paths.

1   3. The method of claim 1, further comprising:

2   storing a copy of the data only at the server.

1   4. The method of claim 2, in which the streaming data are multimedia.

1   5. The method of claim 1, in which the link correlation matrix is

2
$$Cr(L_{ij}, L_{mn}) = 1/2 + \frac{E[(L_{ij} - \overline{L}_{ij})(L_{mn} - \overline{L}_{mn})]}{2\sqrt{E(L^2_{ij}) - (\overline{L}_{ij})^2}\sqrt{E(L^2_{mn}) - (E(\overline{L}_{mn}))^2}},$$

3 where ij and mn are a pair of links connecting two nodes, E is an

4 expectation, L_{ij} and L_{mn} are the metrics for link ij and link mn, and an

5 average $\overline{L}_{ij} = E(L_{ij})$.

1 6. The method of claim 1, in which the metrics include bandwidth, latency,

2 and packet loss rate of the link.

1 7. The method of claim 1, in which the measuring, transmitting,

2 maintaining, and selecting are performed dynamically and periodically over

3 a time window.

1 8. The method of claim 5, in which the path correlation matrix is

2
$$Cr(Path_A, Path_B) = \sum_{a \in A}\sum_{b \in B} Cr(a, b),$$

3 where the path$_A$ includes a link set $a \in A$ and the path B includes a link

4 set $b \in B$.

1 9. The method of claim 8, further comprising:

2   first selecting a first path based on the metrics;

3   updating an available bandwidth of each link according to previously

4 selected paths;

5   determining a correlation cost (cc) for each link L with respect to a

6 previous selected link set S of a path as

7
$$Cr_S^L = \sum_{a \in S} Cr(L, a);$$

8   combining the correlation cost and the metrics to obtain a cost for

9 each link using a cost function

10    $$Cost_S^L = \alpha \cdot Cr_S^L + \sum_{i=1}^{R} \alpha_i W_r(i,j),$$

11   where W are the metrics, and α and α_I are weighting factors; and

12   selecting a next shortest path based on the updated cost $Cost_S^L$; and

13   repeating the updating, determining, combining, and selecting until

14 the plurality of paths have been selected.